Hexatricha pulverulenta Westwood.

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Hexatricha pulverulenta Westwood is a small native longhorn found on *Nothofagus* and the exotic *Pinus radiata* throughout New Zealand. The following is a description of the external anatomy and reproductive organs with short notes on habits and life history.

My thanks are due to Dr. Miller, to Professor Kirk, who supervised the original work, and to Mr. L. J. Dumbleton, who has supplemented my observations on the life history.

HABITS.

The pine tree (*P. radiata*) is attacked shortly after death. With her mandibles the female cuts in the bark a transverse oviposition hole 2–3 mm. deep, and deposits an egg between the bark and the wood; the egg is thrust down at right angles to the hole for several millimetres. If the bark is more than ¼ inch in thickness the female chooses a fissure in which to make the oviposition hole, which is sealed by a secretion after deposition of the eggs. One egg is usually laid, although up to four have been found. In captivity the females never oviposited in a branch on the ground, but always preferred an upright one, the beetles in the field being found on the upright main stem. Eggs laid in the laboratory were found to hatch in 10 to 19 days, taking 10 days in hot weather; they have been found in the field from October to April.

The beetles with their powerful mandibles cut off shreds of bark, feed through adult life and eat more or less continuously in captivity. Beetles were observed to eat round the margin of a hole in the bark (e.g., enlarging an oviposition hole), and would rarely make a hole for themselves. They did not touch green pine needles, but when kept for a short time with only "manuka" (*Leptospermum scoparium*) twigs were found on dissection to contain green matter in the alimentary tract. They are reluctant fliers and were not observed in flight in the open. They stridulate when caught, making a squeaking noise, and when agitated wave their antennae around. The period of adult life is evidently fairly long, beetles having been kept in captivity for more than three months, from March to June. They have been observed in the field from October to April.

The young larvae bore shallow tunnels between the bark and the wood, and seem to prefer the bark; they were not observed to bore into the heart wood. The length of the larval life is not known, but it is probably 2–3 years. A freshly-hatched larva grew from 3 mm. to 10 mm. in 5 weeks, but a larger larva kept for several months did not grow appreciably; this may have been due to the fact that the conditions were not close enough to the normal state. The larvae were observed to undergo ecdysis, but the length of time between moults was not ascertained, as those kept for 6 months did not undergo more than one moult. The larvae appear to be able to exist in very dry bark, although they shrivel and become very short,

evidently living on their fat content. They prefer a moist environment, but if kept in very moist bark the mortality is high.

Pupation may occur in a shallow cell lined with coarse shreds of wood and excavated between the bark and wood, or in a vertical chamber 1–2 inches deep in the wood. Pupae have been found from mid-November to the end of February, the pupal period lasting 30 days. The adult emerges from an irregular hole in the bark. Cocoons of *Mesostenus albopictus* were found in the larval burrows, and this species probably parasitises the larva.

Description.

Egg.

The egg (fig. 40) is yellowish-white with an unsculptured chorion; it is elongate, being 3 mm. long by 1 mm. wide, and is usually flattened by the pressure of the bark.

Larva.

The mature larva, covered with bronze coloured setae, is smaller posteriorly, longish and slightly flattened more especially at the anterior end, and is white except for the brown head and the brownish anterior edge of the pronotum. The legs are vestigial, reduced to a ring of short setae, though ambulatory ampullae are developed. The size of the mature larvae varies, but some have been found up to 35 mm. in length and nearly 5 mm. across the prothorax. The larvae are negatively heliotropic.

Head.

The head (figs. 1, 2 and 8) is more or less oblong, with its sides converging posteriorly and the posterior end rounded; it is depressed, being about twice as wide as it is high, and is deeply imbedded in the prothorax, only the anterior, more strongly pigmented half being usually visible. The colour of the head is striking; the more heavily chitinized parts are a reddish-brown which on the very strongly chitinized areas becomes dark brown to blackish (e.g., the mandibles), while the less chitinized portions are bronze, and the membranes whitish. The hairs are bronze, the longer ones being brown.

The labrum is visible at the antero-dorsal surface of the head, is movable, and can be partly retracted beneath the clypeus. It is rounded anteriorly and widest medially, being nearly three times as wide as it is long. Anteriorly, it carries hairs which are shortest at the edge; posteriorly, it is slightly chitinized. On its ventral surface (fig. 7) are convergent hairs. Its posterior ventral corners are supported by a chitinous bar on either side, while the ventral surface is continuous posteriorly with the epipharynx.

The epipharynx, which is supported on either side by a chitinous rod, has a slightly chitinized area for a short distance along the median line.

The clypeus is only slightly chitinized; it is widest posteriorly, being attached to the epistoma for the entire width between the articulations of the mandibles; it carries no hairs.

The frons is roughly triangular, and is defined laterally by the frontal sutures which are distinct and extend forward to the antennal rings which they bisect; the rings are, therefore, open behind. The

frons is brown in colour, strongly chitinized at the *epistoma,* and is divided by an incomplete median suture on each side of which are eight setae.

The epistoma, which is not produced over the clypeus, carries three epistomal setae on either side.

Posteriorly, the dorsal surface of the head is covered by the *epicranial halves* which extend laterally and cover the sides of the head as well; they meet in the mid-line behind the frons, where there is an attachment for the superior retractor head muscles, and are fused down their entire length. Posteriorly the halves are rounded, being developed into a small point at the posterior end of the epicranial suture.

The gena on each side is shouldered, and carries a few long hairs; the single ocellus, situated on the anterior part of each gena, projects slightly and faces forward, while it is separated from the antennal ring by a fold of chitin.

The antennae are three-jointed, frail and short, the terminal segment being minute; the basal membrane is large, and each antenna is readily retractile into the antennal ring, which is broken behind by the frontal suture.

The mandible (figs. 3 and 4) is elongated, being one and a-half times as long as it is wide at the base, which is the most massive part; the apex is produced and a tooth is borne on the inside edge, anteriorly and dorsally. Some mandibles appear shorter and stouter in comparison, but in these cases the tips have been broken off. The cutting edge is oblique and short. The surface of the mandible is finely granulate and has a few wrinkles towards the base; one or two setae are carried on the outer face. There is a well-defined condyle on the ventral outside corner, which articulates against the smooth pleurostoma. The ginglymus is well developed on the dorsal edge.

On the ventral surface of the head, the *mentum* and *submentum* are not distinct. According to Craighead (2), the cardo, the maxillary sclerite (maxillary articulating area), and the submentum are fused for the entire distance between the ventral articulations of the mandibles. This fused area, which has ben called the compound fused area in the following description, is barely chitinized and almost transparent; the muscles for the labium and maxillae can be seen through it.

The labium (figs. 5 and 6) proper consists of a median ligula, at the base of which are attached two fused labial stipes, each of which carries a two-jointed labial palp. The palps lie on either side of the ligula, and are bronze in colour, the intersegmental membranes white, carrying bronze hairs. The membrane joining the palp to the stipes carries a few hairs, while that joining the two joints of the palp has one or two. Laterally the stipes are bronze, but in the midline more or less transparent, and are carried by the mentum, or that portion of the compound fused area representing the mentum. The dorsal, or inside surface of the ligula, carries a few hairs; posteriorly it is continuous with the hypopharynx, which is supported by a narrow, slightly curved, chitinous bar on either side.

The maxillae (figs. 2 and 5) consist basally of the stipes, which are attached to the outer anterior portion of the compound fused area, and which bear distally the palpifers; the palpifer carries on the inside the lacinia, and on the outside the three-jointed palp.

At the base of the stipes is a bronze coloured, more strongly chitinized band, which is broader on the inner side than on the outer; a few hairs are carried just in front of this band. The palpifer is large, more strongly chitinized ventrally, and bronze in colour. The membrane attaching the lacinia and the palp to the palpifer carries a few hairs along its posterior edge.

The lacinia at its base is cylindrical and chitinized; distally it is swollen and more membranous, carrying a number of hairs. The segments of the palp become progressively smaller, the end one being less than half the width of the basal one; a few hairs are carried on the intersegmental membranes. Both the maxillae at the posterior ends of their stipes, together with the labium at the posterior end of its fused stipes, are retractable beneath the compound fused area; there are a few hairs carried on this area towards the anterior end, and four others spaced two on either side posteriorly. When the maxillae and the labium retract, the compound fused area bends in as far as the anterior row of hairs.

Anteriorly the *hypostoma* is fused to the compound fused area; medially it is fused with the gula, the gular suture being but a faint median line. The outer posterior corners of the hypostoma are developed into raised areas; about the centre of the outer side, the raised area ends in a rounded protuberance. *H. pulverulenta* is the only Lamiid in which this ridge has been found. Medially, it is not so steeply raised, the posterior side dipping down sharply to the occipital foramen. Setae are carried on either side of the gular suture, and anteriorly the line of these setae turns towards the anterior outside gular angle. There is a slight depression in the epicranium before it joins the hypostoma.

The occipital foramen is large, posterior and ventral. Round it is attached an extension of the prothoracic skin which forms a continuous band, the collar, attaching the head to the prothorax. This allows the head to be extended and retracted by the superior and inferior retractor muscles.

According to Craighead (2), there are certain characteristics which distinguish the Lamiinae from the rest of the Cerambycidae. The larval head of *H. pulverulenta* exhibits some of these characteristics well, for example: the oblong head; the fusion of the dorsal margins of the epicranial halves down their entire length; the elongated mandible; the epistoma not produced over the clypeus; the cardo, maxillary sclerite, and submentum fused; the antennae very retractile and small.

Thorax.

The prothorax is much the largest of the three thoracic segments, and across the pronotum is the widest part of the larva; the mesothorax is smaller than the metathorax.

The pronotum is a large rectangular plate, it is not fused with the alar area, but separated from it by the lateral suture, which is only present posteriorly. The anterior area of the pronotum is more or less chitinized, smooth and shining, carrying a few hairs anteriorly and laterally; the median area carries a few short hairs, while the posterior area is shining and smooth, except that it is broken by longitudinal striae. There is a narrow postnotal fold just behind the pronotum.

The protuberant fold along the side, the epipleurum, which represents only a portion of the adult pleurum, is well marked posteriorly, but it is less conspicuous in the thoracic segments.

The alar areas lie on either side of the notum. The epipleurum is separated from the pro-alar area by a narrow furrow, the dorso-lateral suture, and ventrally from the sternum by the ventro-lateral suture.

The presternum is well developed, forming anteriorly one large slightly chitinized plate. The eusternum is weakly defined, being roughly triangular in shape; behind it lies the narrow, smooth sternellum.

The mesothorax is very small, and the parts of the mesotergum not distinct. A spiracle is carried laterally at the anterior end of the alar area, above the epipleurum; this is the largest of the spiracles. The epipleurum can be distinguished, and the hypopleurum is not definitely defined.

The sternum is divided by a median transverse line, round which are developed small protuberances similar to the ampullae of the abdominal segments, except that the protuberant area is much narrower. The ambulatory ampullae are described later.

In the metathorax the different structures of the tergum are obscured as ampullae are developed. Laterally the alar area is not well defined. The presternum is fused with the anterior part of the epipleurum. The hypopleurum is not definitely distinguishable and the sternum is developed medially into ampullae.

The small circles of short spikes representing the vestigial legs are carried on either side of the sternellum in the prothorax, and of the sterna in the mesothorax and metathorax.

Abdomen.

The nine abdominal segments are shortest anteriorly; the first four or five become progressively rounded and longer, the remainder becoming slightly smaller to the small ninth segment. The tenth segment, according to Craighead (2), is probably represented by the anal lobes. In the abdomen the epipleura are protuberant and separate the segments into dorsal and ventral regions. Craighead considers that these regions can be divided into certain areas, some of which are homologous with the thoracic areas, and are similarly named; others are questionably homologizable, and others again are special abdominal developments. In the latter two cases Craighead has applied new names.

The epipleurum is protuberant on all the segments, more strongly so on the last few, especially the two terminal ones. There is a pleural tubercle on each epipleurum, except in the ninth abdominal segment; the tubercle is oval and lies obliquely, the anterior end being more ventral in position than the dorsal. The number of setae each tubercle carries varies—the first usually with two, the rest progressively with more, the last carrying up to twenty; some of the setae are short and bristle like, others are much longer.

The dorsal and ventral protuberances on the first seven segments are called the ambulatory ampullae, and are used by the larvae in moving in the burrows; they are irregularly tuberculate, and a longitudinal depression divides each ampulla into two lobes. The tubercles, which have a shining surface and carry no hairs, are arranged round a transverse depression which in the anterior ampullae is narrow; in the posterior ones, at the outer ends, it broadens; dorsally, especially in the posterior segments, this transverse depression is obscured, there being three or four rows of irregular tubercles. The ampullae are formed from a dorsal protuberance of the prescutum, scutal plate, parascutum, and scutellum, and from a ventral protuberance of the eusternum and sternellum.

The scutal plate is not well defined. In front of it is the ill-defined prescutum, and behind, the scutellum. The parascutum lies on the side and is also not well defined; below it and above the epipleurum lies the spiracular area, the ventral limit of which is well defined. There is a small depression lying between the parascutum and the spiracular area. The spiracle lies slightly towards the anterior end of the surface of the spiracular area, and is not on a protuberance. Ventrally the different parts are not easily distinguishable. The presternum is not separated from the epipleurum, and appears as an anterior ventral extension of the epipleurum. The ventral ampullae are divided by a transverse depression. The eusternum is the region in front of the line, and the sternellum the region behind. These are fused laterally with the coxal lobe and hypopleurum, which are not definitely defined, but which lie directly below the epipleurum.

The ninth abdominal segment is partly retracted into the eighth. On either side of the tergum is a small depression. The anal lobes surround the anus, a median dorsal and two others latero-ventral in position. These lobes carry setae.

The dorsal and ventral wedge-shaped perpendicular bands developed in the intersegmental membranes, the dorsal and ventral cunei, are fairly wide. The ventral cuneus is situated behind the dorsal, thus allowing a large amount of movement between the segments. In the thorax the cunei lie in the same plane so that little extension is possible.

Pupa (fig. 11).

Head.

The head is bent at right angles to the body, the mouth parts lying over the pair of prothoracic legs. The tips of the mandibles are the only strongly chitinized parts. Hairs are developed on the labrum and are visible through the membrane.

The compound eyes have reached an advanced stage of development, their outlines being plainly visible. The membrane above the frons and the eyes carries three or four setae which are borne on small papillae. The membrane directly above the gena carries two setae; that covering the clypeus carries the two lots of three epistomal setae.

The palps of the labium and maxillae are not fully developed. They extend beyond the mandibles, the segments being more or less visible. The ligula appears as two fused rounded processes. The antennae, which are carried at the anterior end of the head on slightly raised processes, are eleven jointed. They are recurved so that their extremities reach almost to the level of the beginning of their third segment; the long hairs carried by the adult antennae are not yet fully developed.

Thorax.

The prothorax is the largest of the three thoracic segments, as in the larva and adult. On the membrane covering it are carried an anterior row of setae, and median and posterior areas with setae.

The mesothoracic spiracle lies laterally between the pro- and mesothorax. The elytra are on either side of the mesothorax; they are directed outwards and backwards and are not fully developed, although they carry hairs on their outer ends. The outline of the mesonotum can be discerned and is slightly raised posteriorly; a row of setae is carried on the membrane covering the posterior raised portion. The mesothorax is the smallest of the three thoracic segments.

Laterally the metathorax carries the wings which lie below and behind the elytra; they appear fleshy and are not a quarter of their final length. The different parts of the metanotum are not distinct except for the metascutellum, which is distinguishable as a median dark band, narrower posteriorly. A few setae are carried laterally on the pupal integument above the metanotum.

The legs are comparatively far advanced in their development. The coxa, trochanter, femur, tibia, and tarsus are all distinct. The tarsus is five-jointed, and the tarsal pads are developed. Hairs are also carried on the other segments. The claws and tibial spines are developed but not chitinized. The legs are folded ventrally, the junction of the femur and tibia being posterior, that of the tibia and tarsus anterior, the tarsus lying parallel to the mid-ventral line. On the integument covering each femur are a few scattered setae, while others are arranged in a row at the posterior end.

Abdomen.

The abdomen has nine segments plainly visible; the tenth is small and more difficult to determine. The dorsal integument carries an anterior and a posterior row of spines, as well as a few setae on each segment, more especially on the posterior ones. The seventh tergum is the largest.

The first abdominal spiracle is large, as in the adult, the remaining eight are small. The integument covering the pleura is very wrinkled, and that covering the sterna is smooth and free from spines

or setae. Anteriorly the first two abdominal sterna are represented by folds in the membrane. The third sternum is very large and the next three are smaller, the seventh being slightly larger again.

The eighth segment, which carries a spiracle not functional in the adult, is very much smaller than the seventh, while the ninth is smaller still. The sterna of the eighth and ninth segments are divided by an incomplete median longitudinal line.

The ninth segment dorsally carries a well-developed spine on the tergum, and laterally and ventrally has short spines as well as setae on the swollen pleural region.

Ventrally the beginning of the genital invagination (figs. 9 and 10) can be seen between the ninth and tenth sterna. On the ninth sterna posteriorly are developed two papillae which help to form the ventral lip of the invagination. The tenth segment is small and is terminal in position, the dorsal portion carrying two spines, and the ventral portion forming the dorsal lip of the invagination. The integument is very wrinkled between the dorsal and ventral portions of the tenth segment.

The eighth, ninth and tenth segments are invaginated in the adult, the ninth and possibly portions of the eighth, helping to form part of the adult genitalia. The tenth may also help or, more probably, it is totally missing.

Imago.

The beetle (fig. 12) varies in size from 13 mm. to 21.5 mm. in length, the measurements being taken from the tip of the mandibles to the ends of the elytra; the average length is about 19 mm., and the females are slightly broader than the males. The insect is strikingly marked with yellowish-white and blackish-brown hairs.

Head (figs. 15, 18 and 19).

The head is a strongly chitinized capsule with most of the sclerites fused and only a few sutures showing. The epicranial suture is complete, and terminates in a pointed process at the dorsal surface of the occipital foramen. Hairs cover the head in patches; the chitin is blackish-brown and the hair patches yellowish, giving a mottled appearance to the head.

The vertex is depressed and the antennae are borne on slightly raised processes, which are surrounded by the eyes on the outer side. The post-clypeus is fused with the greatly reduced frons. The anteclypeus is membranous and bears long hairs. The gena on either side is slightly swollen posteriorly to the junction with the clypeus; between this swelling and the junction it bears a facet for the articulation of the ginglymus of the mandible and ventrally a cavity for the condyle of the mandible of that side. The genae do not meet ventrally, being separated by the gula. The latter is broader posteriorly, narrows slightly and then broadens out anteriorly; posteriorly it is separated from the genae by the gular sutures, and anteriorly bends downwards forming a depression before it curves forwards to carry the submentum. The occipital area has two indented lobes dorsally.

The eyes are convex, crescentic in outline, and constricted medially; they curve round the base of the antennae posteriorly and come together more closely dorsally than anteriorly. There are hairs round

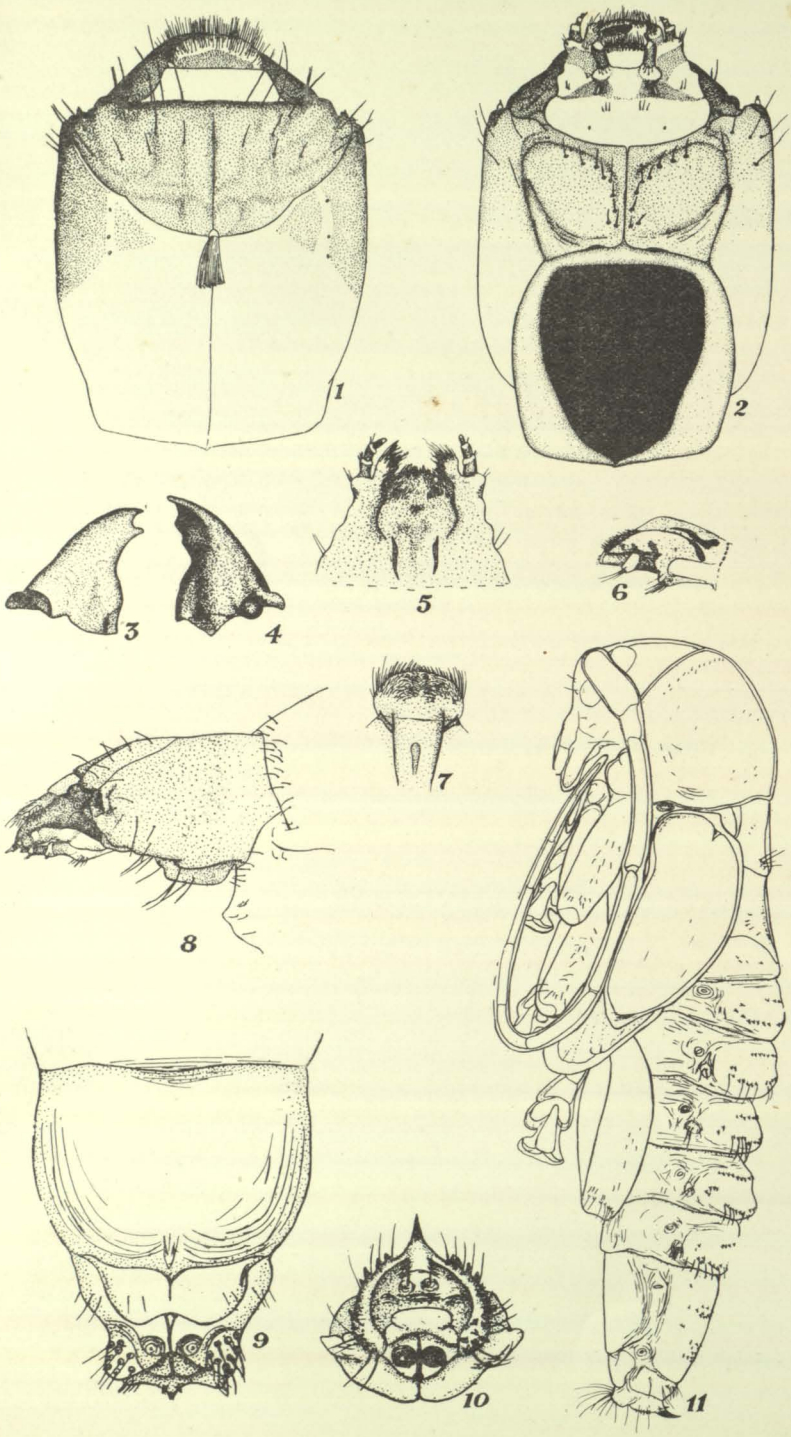

FIG. 1.—Larva: head, dorsal view. FIG. 2.—Larva: head, ventral view. FIG. 3.—Larva: left mandible, dorsal view. FIG. 4.—Larva: left mandible, ventral view. FIG. 5.—Larva; labium, maxillae and hypopharynx, dorsal view. FIG. 6.—Larva: labium, side view. FIG. 7.—Larva: labrum and epipharynx, ventral view. FIG. 8.—Larva: head, side view. FIG. 9.—Pupa: last segments of abdomen, ventral view. FIG. 10.—Pupa: last segments of abdomen, posterior view. FIG. 11.—Pupa: left side of pupa.

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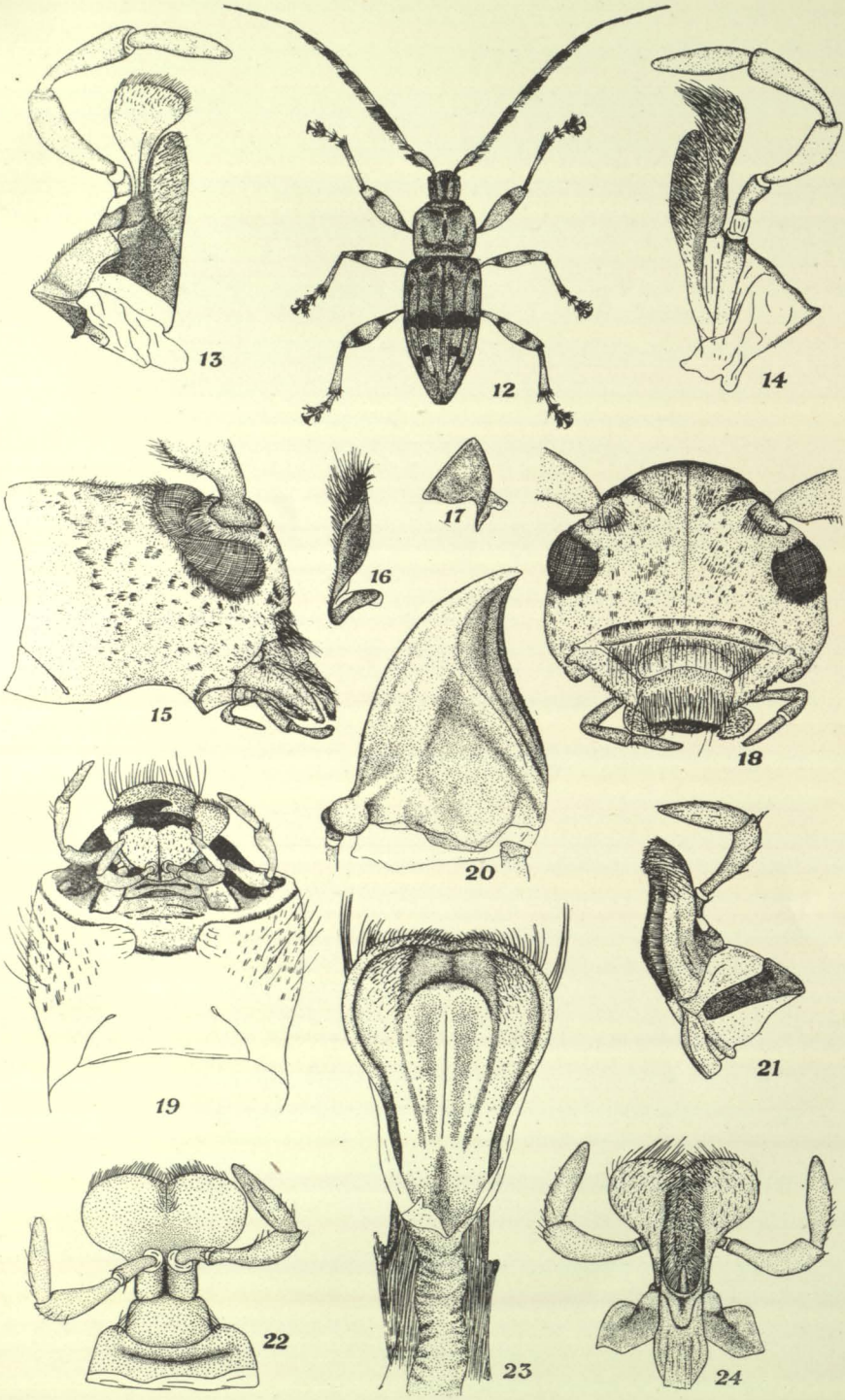

FIG. 12.—Imago: male, dorsal view. FIG. 13.—Imago: right maxilla from an inside ventral aspect. FIG. 14.—Imago: right maxilla from side of attachment. FIG. 15.—Imago: side view of head. FIG. 16.—Imago: right galea, side view. FIG. 17.—Imago: right cardo. FIG. 18.—Imago: head, anterior view. FIG. 19.—Imago; head, ventral view. FIG. 20.—Imago: right mandible, ventral view. FIG. 21.—Imago: labium and hypopharynx, side view. FIG. 22.—Imago: labium, ventral view. FIG. 23.—Imago: labrum and epipharynx, ventral view. FIG. 24.—Imago; labium and hypopharynx, dorsal view.

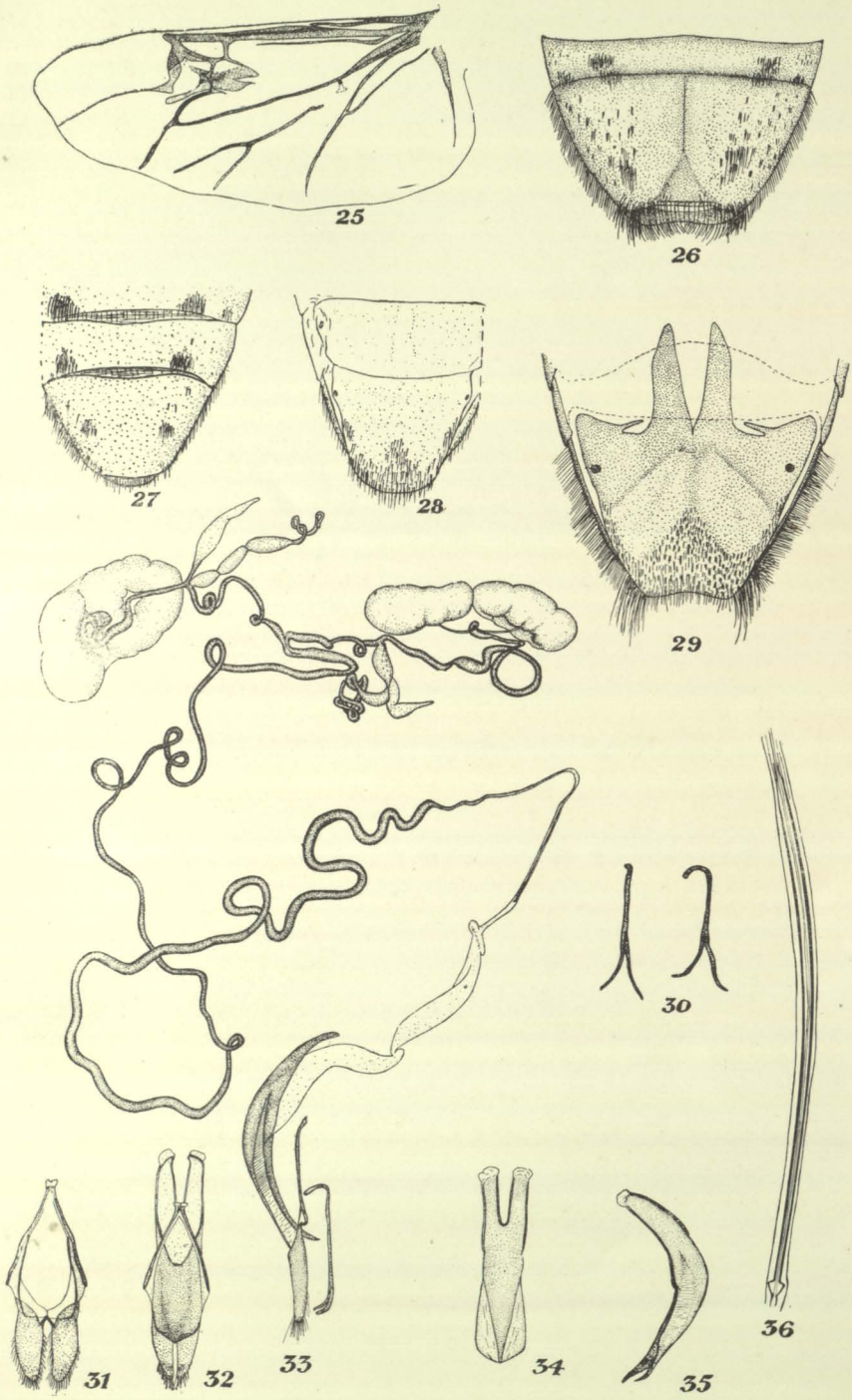

FIG. 25.—Left wing. FIG. 26.—6th and 7th abdominal stergum of female, ventral. FIG. 27.—6th and 7th abdominal stergum of male, ventral. FIG. 28.—6th and 7th segments of abdomen of male, dorsal. FIG. 29.—7th segment of abdomen of female, dorsal. FIG. 30.—Spicula gastralia, ventral. FIG. 31.—Tegmen, dorsal. FIG. 32.—Ventral view of tegmen and median lobe in natural position. FIG. 33.—Male reproductive system. FIG. 34.—Median lobe, dorsal. FIG. 35.—Median lobe, left side. FIG. 36.—Chitinous rods.

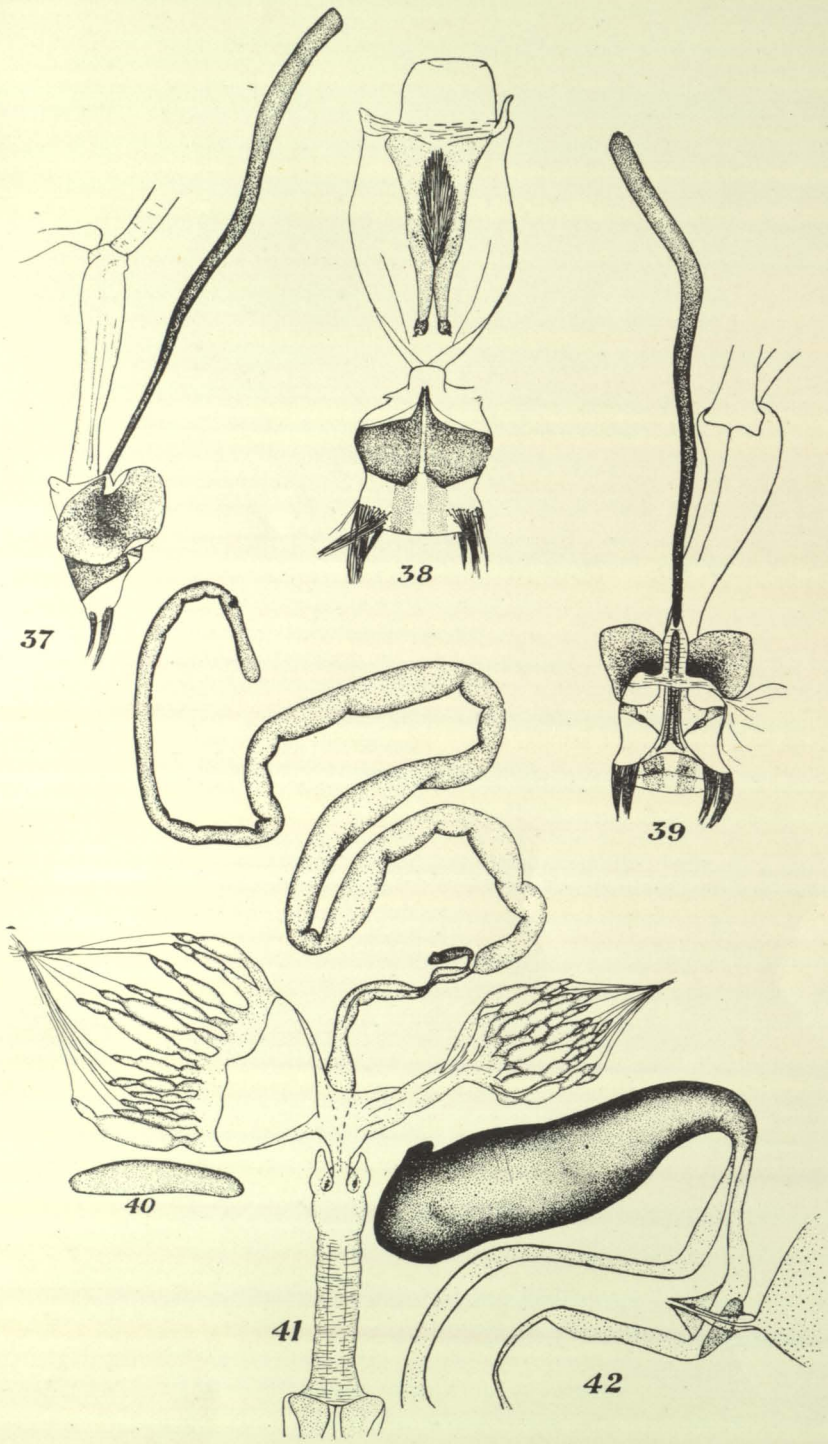

FIG. 37.—Ovipositor, from left side. FIG. 38.—Ovipositor, dorsal, membranous tube slit up to expose end of ovipositor retracted within. Anus and rectum cut across to show anterior ends of coxites and vagina attachment to membranous tube. FIG. 39.—Ovipositor, ventral. FIG. 40.—Egg. FIG. 41.—Female reproductive system —right oviduct slit up, ventral view. FIG. 42.—Spermatheca and portion of the bursa copulatrix.

the margin giving the appearance of eye lashes; these are most strongly developed ventrally and postero-dorsally as well as anteriorly in the median line. The ommatidia are hexagonal and uniform.

The antennae are very long, longer than the body, and typically eleven-jointed. The scape is the thickest, the pedicle shortest, and the third joint longest. The first six segments, especially the first four of the flagellum, carry long setae posteriorly along their length. The basal colour of the antennae is a blackish brown, but white, yellow, brown, and black hairs arranged in bands give the antennae the characteristic banded appearance. The clothing hairs of the scape are brown, those of the pedicel blackish-brown, while the long setae on the scape are yellowish and on the pedicel black. In the next four joints, the clothing hairs proximally are white, and distally brownish-black; the long setae are proximally yellow, and distally black. The seventh joint carries a few long setae on the proximal posterior border; these setae are not as long as those of the other joints. The last five joints exhibit the same basal colour, becoming a little lighter toward the extremity; they are covered with short clothing hairs which are white at the base but otherwise blackish-brown. The joints are progressively shorter from the third to the eleventh, the latter being rounded at its tip; all articulate with their neighbours except the pedicle, which appears fused to the third joint. The scape articulates with the head by means of the antennary socket.

The lateral anterior inner parts of the *labrum* bear setae as well as the external portion. On the inside the median section is raised to form the *epipharynx* (fig. 23), the sides of which are supported by chitinous rods posteriorly.

The *mandibles* (fig. 20) are well developed, strong, hollow and curved, with a sharp cutting inner edge slightly serrated, and a broader outer edge which carries hairs; there is no tooth as in the larval mandible. The condyle is well developed and articulates in the socket of the gena which is ventro-laterally placed. The fronto-clypeal facet for the ginglymus is dorso-lateral. Both dorsal and ventral surfaces of the mandible are smooth; on the dorsal surface near the base of the inner margin of the mandible there is a small hollow or pit filled with short hairs; there is no crushing area. The mandibles are used for cutting the bark scissor-fashion and evidently the small pieces shredded off do not undergo further mastication, the gut being found to contain comparatively large pieces.

Each *maxilla* (figs. 13, 14 and 17) consists of a basal cardo (fig. 17) which is completely hidden from view when the parts are lying *in situ;* it is narrower basally and has a half turn, the line of attachment to the head being at right angles to the line of attachment to the stipes. The stipes is visible ventrally when the parts are *in situ;* it is roughly a rectangle and hairs are present along its outer margin. Antero-laterally the stipes carries the palpifer which bears the four-segmented palp; the connecting membranes are white and the joints of the palp blackish brown with comparatively few setae; this absence of setae is an unusual feature; the basal joint is the shortest, the next two the longest and broadened anteriorly, while the terminal one is obtusely pointed.

The stipes bears the two-pointed galea between the lacinia and the palpifer. The proximal portion or the blade of the galea (fig. 16) is narrower and triangular in cross section, while distally it broadens and flattens; it bears numerous hairs on the anterior end of the outer surface. The sub-galea is at right angles to the blade.

The distal portion of the lacinia, which is in two parts, has long hairs and is carried by the basal portion which is partly fused to the outer border of the sub-galea.

The labium (figs. 21, 22, and 24) consists of a mentum (Imms 3) or a submentum (Tillyard 10) bearing anteriorly two labial palpigers which carry the three-joined labial palps, the terminal joint of which is obtusely pointed; there are a few setae on all three joints. Joining the palpigers to the mentum is a slightly chitinized membrane hidden from view by the mentum when the parts are lying in their normal position.

The ligula is bilobed and flat anteriorly; it carries a few hairs on the ventral surface, while anteriorly, in the mid-line of the inner surface, there are numerous setae, which are shorter and denser posteriorly.

The hypopharynx anteriorly is a smooth median process on the floor of the mouth; posteriorly it widens and becomes more membranous.

Wings.

The hind wings (fig. 25) are membranous and transparent, nearly half as wide as long, and when fully extended as in flight they are about four-fifths of the total length of the whole insect; they are covered by minute spines, longer along the posterior margin.

The venation of the wing follows the Cantharid type. The veins present are Costa, Subcosta, Radius, Radial sector, and $R._2$, $R._3$, $R._4$ and $R._5$, Media, $M._1$, $M._2$, Cubitus, $Cu._1$, $Cu._2$, Anal, $A._1$, $A._2$, $A._3$, and certain cross veins, m.–cu. being incomplete. The costa is reduced, being present only at the humeral angle, while the subcosta extends for about a third of the wing length.

$R._1$ is a large convex vein which runs more than two-thirds of the way down; a small vein is given off posteriorly to it which is presumably the radial sector; $R._2$ appears as a recurrent branch of the radius; $M._1$ and $M._2$ coalesce distally forming a loop (Cantharid type), and $M._2$ continues to the wing margin; the cubitus is incomplete, only the distal portion remaining with $Cu._1$, and $Cu._2$ continuing towards the margin; the proximal end of the media is thickened, which may represent the fusion of M. and Cu. at their basal ends; three anal veins are present at the base of the wing. Halfway down the length of $A._1$, $A._2$ either coalesces with it, or is joined by a cross vein to it, in which case the rest of $A._2$ is missing. $A._3$ is very broad at the base, narrows distally, but does not reach the wing margin. There is a small fragmentary transverse vein given off from M. which is probably m.–cu.; in some wings it is attached to M., in others it is free, but its other end is branched and is thus T-shaped. Between $R._2$ and $M._1$ there are several reduced veins. It was not possible to trace the development of the wings, so it cannot be said with certainty

which veins the reduced ones represent. Probably the vein running to the margin is the distal end of $R._4$ or represents $R._4$ and $_5$, and $R._3$ is the fragmentary vein lying between $R._2$ and $M._1$. If this is the case, there are then cross veins $r._1$–$r._2$, $r._2$–$r._3$, and $r._3$–$m._1$.

Abdomen.

There are seven visible terga and five visible sterna in the abdomen. In the male a terminal segment is retracted within the abdomen, and in the female one or more of the terminal segments go to form part of the ovipositor. In the female the seventh tergite (fig. 29) is much larger than that of the male (fig. 28); it is as strongly chitinised as in the male, and there are two antero-median processes which lie below the tergites of the preceding segments and to which muscles of the ovipositor are attached. The seventh sternite (fig. 26) is much broader and longer than that of the male (fig. 27); there is a median longitudinal furrow which widens posteriorly and which is absent in the male, a character giving the easiest method of distinguishing the sexes.

The Male Reproductive Organs (fig. 33).

The testes are paired, and in each, held together by a membrane, there are two lobes which are round flattened bodies, the centre being thinner than the sides. The greatly coiled *vas deferens,* formed by the union of the two small *vasa efferentia* which leave the inner hollowed centre of each lobe of the testes, lies between the lobes and leaves the surrounding membrane about the point where it is joined by the accessory gland and seminal vesicle. In *Saperda carcharias,* belonging to the same sub-family, instead of a separate *vas efferens* for each lobe there is only one which passes through the second lobe.

The accessory gland, a comparatively small, blind structure with the anterior end bluntly pointed, is slightly swollen before it narrows and joins the *vas deferens.*

The seminal vesicle is very narrow anteriorly and greatly coiled, but before joining the *vas deferens* it swells out and is usually twisted three or four times.

The ejaculatory duct, greatly coiled and very long, is surrounded by a thick muscular coat posteriorly. Near its termination it is supported by two chitinous rods (fig. 36) which are long, round, and narrow, being attached at their basal ends to the beginning of the internal sac into which they project; these rods are evidently structures for strengthening the protrusile end of the ejaculatory duct, and presumably form the transfer apparatus.

The internal sac, a very long structure, lined with patches of small spines, is divided into three parts by two well-marked transverse folds, the anterior part being very narrow and the two posterior ones much larger. The beginning of the second part is slightly bulbous, and muscles are attached to it. The third part is nearly equal in length to the other two together, and widens to about three times its original width before the attachment of its posterior end to the inside posterior end of the median lobe, where it opens to the exterior through the median orifice. In the 2nd and 3rd parts, dorsally and

ventrally, there are two longitudinal bands of granular thickening which narrow at the transverse fold between the two parts and which terminate about halfway down the third part.

The median lobe (figs. 32, 34 and 35), a curved hollow structure with a pair of anterior struts, is formed by a dorsal and a more strongly thickened ventral sclerite which join latero-anteriorly, and are connected latero-posteriorly by a slightly chitinized membrane. The ventral sclerite is much broader than the dorsal, and not so curved. The internal sac enters the median lobe through a median ventral foramen over which the two struts curve dorsally, the ventral sclerite passing up on either side of the foramen to join the dorsal sclerite. The internal sac is attached internally to the posterior end of the median lobe separating the two sclerites, each of which forms a lip to the median orifice. The internal sac is not attached to the extreme tip of the ventral sclerite, which forms consequently a more marked lip towards which the tip of the dorsal sclerite curves down. When the internal sac is everted the two sclerites are forced apart to allow the internal sac to be pushed through.

The tegmen (figs. 31 and 32) surrounding the median lobe is ring-shaped with a pair of well-developed lateral lobes carrying a few stiff hairs on their distal ends. The basal piece has possibly fused with these lobes and is not developed to the extent that it is in *S. carcharias;* basally to this the lateral lobes are joined. To the outside of lateral projections of the basal piece extending inwards, but not meeting in the midline, are attached a pair of ventral struts which meet basally; these struts are comparable with the stout chitinous arch described by Ritchie (5). The lateral projections and dorsal fused parts appear to be all that are chitinized of the basal piece. According to Sharp (7) the chitinized condition of some parts is secondary to the membranous condition; if this were to hold for the basal piece it might be that the ventral part is membranous, and thus the membranous basal piece would be in the same position as the chitinized basal piece of *S. carcharias.* There would be no distinction between the membranous basal piece and the second connecting membrane.

The spiculum gastrale (fig. 30), a curved chitinous rod forked posteriorly, but varying in shape in different individuals, is found lying below the median lobe and the tegmen. The anterior end is abruptly curved towards the dorsal surface or, more usually, slightly to one side; the posterior end is bi-fid and bends towards the dorsal surface.

The Female Reproductive Organs (fig. 41).

The two ovaries, one on either side of the abdomen consist each of twelve egg tubes, each tube ending in a terminal chamber which is bottle-shaped and has a filament at its apex; these filaments come together at a distance away from the end cells of about half the length of the tubules. The ovaries are arranged in a circle, and open into the swollen end of the comparatively short oviduct.

The thin-walled *accessory gland* is a long coiled tube, narrowing anteriorly to an obtuse apex. The secretion which entirely fills the cavity is probably that which is used by the female in sealing the

oviposition holes. The opening of the narrow chitinous tube which connects the gland to the *bursa copulatrix* is situated at the apex of a protuberance projecting into the latter.

The spermatheca (fig. 42) is a round, short, blunt, chitinous tube with a very narrow duct at right angles to it which connects it to the thick-walled bursa copulatrix. The inner surface of the spermatheca is produced into spines, and the cavity is often completely filled with sperms. The *spermatheca* runs parallel to the *bursa copulatrix,* to which it is attached by muscles, especially at its free end.

The bursa copulatrix, the walls of which are very muscular, narrows slightly, coils three or four times when it straightens out and becomes gradually much wider, while at the same time the wall becomes thinner and less muscular, though there is a strong muscular investment for the full length. The *bursa copulatrix* lies between the oviducts, and, narrowing, enters the vagina dorsally.

The oviducts pass above, and lie between, the muscles which originate on the head of the *spiculum ventrale,* and which are attached to the anterior fold of the membranous tube of the ovipositor. The ducts join ventrally in the median line, to form the common oviduct lying between the *spiculum ventrale* and the ovipositor.

The beginning of the *vagina* is the widest portion of it; ventrally, from the sides of this wider part, there are given off a pair of membranous flaps, each of which has a slight chitinous thickening at its base towards its ventral corner; the common oviduct enters ventrally between these flaps, while the *bursa copulatrix* enters dorsally at the same level.

There is a great development of muscles round the beginning of the vagina; muscles to the ovipositor are attached to it, the ear-like membranous flaps giving a greater area for attachment. The vagina curves, and turns forwards, to recurve and enter the ovipositor; it continues for a short distance before it opens between the ends of the ovipositor.

The ovipositor (figs. 37, 38 and 39) consists of a folded membranous tube, and of several associated sclerites which form a sheath round the posterior end of the membranous part. The apex of the ovipositor consists of two slightly chitinized protuberances, probably the coxites described by Tanner (9); their ends are more strongly chitinized and each carries a tuft of short hairs. These hairs, or the more strongly chitinized tips of the coxites, may represent the styli described by Tanner and Verhoeff (11). Halfway down the length of the coxites, and between the two, there is a membranous flap (presumably the vulva described by Tannar) which protects the opening of the vagina. These processes or coxites are continuous with the membranous tube, the tube being folded at the point where they are attached to it. The anal opening is found dorsally above the coxites. There are certain tufts of short bristle-like hairs on the dorsal and ventral surfaces of the coxites beyond the opening of the vagina. There are also long narrow hairs on the inner margins of the coxites, and on the membrane between the two coxites covering the vagina. The tip of the ovipositor is capable of being pushed out between the more greatly chitinized sheath of the posterior part.

The large dorsal sclerites of the sheath of the ovipositor are united in the median line by a less strongly chitinized membrane. They pass round the side and become much narrower, their ventral portion being very slight. There is a thin rod-like area which is more strongly chitinized, and which lies on either side of the mid-ventral line.

The saddle-shaped lateral sclerites are most strongly chitinized and are attached medially, on their inner surface, to the dorsal sclerites. They are thickest medially, and ventrally spread out slightly, but do not meet each other. The membrane which is attached to the last sternite and tergite of the abdomen is attached at its other end to the posterior margins of the lateral sclerites. From these sclerites numerous muscles arise.

Ventrally there is a rod-like sclerite in the median line with a slight fork at its posterior end. The dorsal and the ventral sclerites are formed into a continuous sheath by membrane; in this membrane there is a pair of longitudinal bands more strongly pigmented than the surrounding membrane. Near the posterior end of this membranous tube there are certain areas on which numerous setae are carried.

The chitinous rod (Ritchie) or *spiculum ventrale* (Verhoeff) (11) and Schedl (6) extends into the abdominal cavity, passing from the ventral towards the dorsal surface inwards, and reaching into the metathorax; this rod is hollow posteriorly, and opens to the exterior on the ventral surface, where it is covered by a membranous fold or pocket. The *spiculum ventrale* varies in shape in different specimens; it is usually not quite straight, and sometimes has a more strongly marked head, but in all cases it is of the same relative length to that of the body of the insect.

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